

REMARKS

In the last Office Action, the Examiner rejected claims 1-20 under 35 U.S.C. §102(b) as being anticipated by U.S. Patent No. 6,304,527 to Ito et al. ("Ito"). Additional art was cited of interest.

In accordance with the present response, the specification has been suitably revised to correct informalities, provide antecedent basis for the claim language, and bring it into better conformance with U.S. practice. Original claims 1-20 have been replaced with new claims 21, 26-44 to improve the wording, correct instances of indefiniteness, and bring the claims into better conformance with U.S. practice. New claims 22-25 and 45-48 have been added to provide a fuller scope of coverage. The title of the invention has been changed to "METHOD FOR FORMING OPTICAL APERTURE, NEAR-FIELD OPTICAL HEAD, METHOD FOR FABRICATING NEAR-FIELD OPTICAL HEAD, AND INFORMATION RECORDING/READING APPARATUS" to more clearly reflect the invention to which the new claims are directed. A new, more descriptive abstract has been substituted for the original abstract.

Applicants respectfully request reconsideration of their application in light of the following discussion.

Brief Summary of Invention

The present invention is directed to a method for forming an optical aperture, a near-field optical head, a method for fabricating the near-field optical head, and an information recording/reading apparatus having the near-field optical head.

The specification (pages 1-4) discloses methods for forming an optical aperture in a near-field optical head. In one conventional method, a tip of the optical head is coated with an opaque film. The optical aperture is formed at a front end of the tip by irradiating a focused ion beam (FIB) at the vicinity of the front portion of the tip to remove a portion of the opaque film to form the optical aperture. However, the use of FIB to form the optical aperture is time consuming and requires the FIB process to be conducted in a vacuum. As a result, the conventional optical aperture forming method is expensive and time consuming.

Furthermore, optical apertures of conventional near-field optical heads have been unable to facilitate the generation of sufficient near-field light for use in effectively recording/reading information to and from a recording medium.

The present invention overcomes the drawbacks of the conventional art.

Figs. 1-3 show an embodiment of a method of producing an optical aperture according to the present invention embodied in the claims. An object 1000 is provided having a substrate 4, at least one conical- or pyramidal-shaped tip 1 disposed on the substrate 4, at least one stopper 2 disposed on the substrate 4 in the vicinity of the tip and having a height substantially equal to a height of the tip 1, and an opaque film 3 disposed at least on the tip 1. A pressing body 6 is disposed relative to the object 1000 so that a surface of the pressing body is disposed over the tip 1 and at least a portion of the stopper 2. The pressing body 6 is then displaced to bring the surface of the pressing body 6 into contact with the object 1000 so that a force component is directed to a front end of the tip 1 to form an optical aperture 8 at the front end of the tip 1. By this method, the optical aperture can be formed faster and more economically as compared to conventional methods utilizing FIB irradiation.

In another aspect, the present invention is directed to a near-field optical head. With reference to Fig. 3, the near-field optical head has a sharpened tip 1 having an optical aperture 8 at a front end thereof and an opaque film 3 covering the sharpened tip 1 and having a plastically deformed portion in the vicinity of the optical aperture 8. By providing the opaque film with the plastically deformed

portion, an optical aperture is realized for the near-field optical head of the present invention which facilitates the generation of near-field light as compared to the conventional art.

The prior art of record does not disclose or suggest the subject matter recited in newly added claims 21-48.

Claims 21-25

New independent claim 21 is directed to a method of producing an optical aperture and requires the step of providing an object having a substrate, at least one conical- or pyramidal-shaped tip disposed on the substrate, at least one stopper disposed on the substrate in the vicinity of the tip and having a height substantially equal to a height of the tip, and an opaque film disposed at least on the tip. Claim 21 further requires the steps of disposing a pressing body relative to the object so that a surface of the pressing body is disposed over the tip and at least a portion of the stopper, and displacing the pressing body to bring the surface of the pressing body into contact with the object so that a force component is directed to a front end of the tip to form an optical aperture at the front end of the tip.

The prior art of record does not disclose or suggest the combination of steps recited in independent claim 21. For example, Ito discloses a method of manufacturing a near-field

optical head having a tip provided with an optical aperture (Figs. 4-6, 9A-9F). As shown in Fig. 10, in order to form the optical aperture, the tip of the probe shown in a finished state in Fig. 9F is irradiated with a FIB (focused ion beam) 41 from a side of a substrate 1 to cut away a top portion of the tip to form the optical aperture (col. 9, lines 45-49). According to Ito, the size of the optical aperture can be freely changed by controlling a slicing depth as shown in Fig. 10 (col. 9, lines 49-50).

Thus in Ito the optical aperture of the near-field optical had is formed by irradiating the tip with a FIB. In contrast, independent claim 21 requires the steps of disposing a pressing body relative to the object so that a surface of the pressing body is disposed over the tip and at least a portion of the stopper, and displacing the pressing body to bring the surface of the pressing body into contact with the object so that a force component is directed to a front end of the tip to form an optical aperture at the front end of the tip. Stated otherwise, in Ito the optical aperture is formed by irradiating the tip of the probe with a FIB, whereas in claim 21 the optical aperture is formed by directing a force component of a pressing body to a front end of the tip. Thus the method disclosed by Ito and the method recited in claim 21 are two completely different ways of forming the optical aperture.

Claims 22-25 depend on and contain all of the limitations of independent claim 21 and, therefore, distinguish from the prior art of record at least in the same manner as claim 21.

Claims 26-28

New independent claim 26 is also directed to a method of producing an optical aperture and requires the steps of disposing a pressing body relative to the object so that a planar portion of the pressing body confronts the tip and at least one portion of the stopper, and displacing the pressing body to bring the planar portion of the pressing body into contact with and to deform a front end of the tip and the at least one portion of the stopper to thereby form an optical aperture at the front end of the tip. No corresponding steps are disclosed or suggested by the prior art of record as set forth above for independent claim 21.

Claims 27-28 depend on and contain all of the limitations of independent claim 26 and, therefore, distinguish from the prior art of record at least in the same manner as claim 26.

Moreover, there are separate grounds for patentability of dependent claims 27 and 28. Claim 27 includes the additional limitations that the displacing step includes the step of deforming the front end of the tip and

the at least one portion of the stopper simultaneously. Claim 28 requires the formation of an optical aperture in each of a plurality of tips by the displacing step recited in claim 26. No corresponding steps are disclosed or suggested by the prior art of record.

Claims 29-33

New independent claim 29 is directed to a near-field optical head and requires a sharpened tip having an optical aperture at a front end thereof, and an opaque film covering the sharpened tip and having a plastically deformed portion in the vicinity of the optical aperture. No corresponding structural combination is disclosed or suggested by the prior art of record. For example, in Ito the optical aperture is formed by irradiating a FIB on the tip of the probe which is covered with the opaque film 5 (Fig. 10). The irradiation of the FIB in Ito clearly does not result in the opaque film having a plastically deformed portion in the vicinity of the optical aperture, as required by independent claim 29.

Claims 30-33 depend on and contain all of the limitations of independent claim 29 and, therefore, distinguish from the prior art of record at least in the same manner as claim 29.

Moreover, there is a separate ground for patentability of dependent claim 33 which includes the

additional limitations that the front end of the sharpened tip projects from the plastically deformed portion of the opaque film. No corresponding structure is disclosed or suggested by the prior art of record.

Claims 34-37

New independent claim 34 is directed to method for fabricating a near-field optical head and requires the steps of forming on a substrate at least one conical- or pyramidal-shaped tip, forming at least one stopper on the substrate in the vicinity of the tip so that the stopper has a height substantially equal to a height of the tip, forming an opaque film on the tip, disposing a pressing body over the tip and at least a portion of the stopper, and bringing the pressing body into contact with the tip to deform a portion of the opaque film in the vicinity of an apex of the tip to thereby form an optical aperture on the apex of the tip. No corresponding combination of steps is disclosed or suggested by the prior art of record as set forth above for independent claim 21.

Claims 35-37 depend on and contain all of the limitations of independent claim 34 and, therefore, distinguish from the prior art of record at least in the same manner as claim 34.

Moreover, there are separate ground for patentability of dependent claims 35-37.

Claim 35 includes the additional limitation that the step of forming at least one conical- or pyramidal-shaped tip comprises the step of forming a plurality of conical- or pyramidal-shaped tips on the substrate, that the step of forming an opaque film comprises the step of forming an opaque film on the tips, that the disposing step comprises the step of disposing the pressing body over the tips and at least a portion of the stopper, and that the bringing step comprises the step of bringing the pressing body into contact with the tips to deform a portion of the opaque film in the vicinity of an apex of each of the tips to thereby simultaneously form an optical aperture on the apex of each of the tips. No corresponding combination of steps is disclosed or suggested by the prior art of record. For example, Ito does not disclose or suggest the formation of plural optical apertures by bringing a pressing body into contact with the tips, and that the optical apertures are formed simultaneously.

Claims 36 and 37 include the additional limitation that the tip and the stopper are formed in a single forming step (claim 36) and the additional step of removing the stopper after the optical aperture is formed (claim 37). Again, no corresponding steps are disclosed or suggested by the prior art of record.

Claims 38-44

New independent claim 38 is directed to an information recording/reading apparatus and requires a recording medium and a near-field optical head comprised of a conical- or pyramidal-shaped tip for transmitting light having a preselected wavelength and an opaque film covering the tip, the tip having an optical aperture at a front end thereof confronting the recording medium. Claim 38 further requires aperture formation controlling means disposed in the vicinity of the tip of the near-field optical head for controlling formation of the optical aperture at the front end of the tip, and a light guiding structure for guiding luminous flux from a light source to the optical aperture of the near-field optical head to generate near-field light for recording/reading information to and from the recording medium.

Thus independent claim 38 recites "aperture formation controlling means" disposed in the vicinity of the tip of the near-field optical head for controlling formation of the optical aperture at the front end of the tip. Under the guidelines set forth by the Court of Appeals for the Federal Circuit, means-plus-function language in a claim must be construed to cover the structure described in the specification, and equivalents thereof, to the extent that the

specification provides such disclosure. In re Donaldson Co., Inc., 29 USPQ2d 1845, 1849 (Fed. Cir. 1994). When claim 38 is construed in this manner, the claimed "aperture formation controlling means" must be construed to cover the structure recited in the specification and equivalents thereof.

An embodiment of the structure of the "aperture formation controlling means" recited in independent claim 38 is disclosed by the method for forming an optical aperture described on page 14, line 8 to page 16, line 23. With reference to the embodiment shown in Figs. 1-3, the "aperture formation controlling means" comprises a stopper 2 disposed in the vicinity of the tip 1 of the object or sample 1000 forming part of the near-field optical head. As described in the specification, the amount of displacement of a plate 6 by a presser 7 is controlled by the stopper 2 to produce an optical aperture 8 of uniform and small size on the point of the tip 1. No corresponding structure, or equivalents thereof, is disclosed or suggested by the prior art of record.

For example, while Fig. 1A of Ito discloses pads 2 in the vicinity of the tip 4 which resemble the structure of the stopper in the embodiment of the invention shown in Figs. 1-3, the pads 2 in Ito do not function at all to control the formation of the aperture on the tip 4 of the probe. Instead,

the sole function of the pads 2 in Ito is to control the state of flying of the slider 1 with respect to the information recording medium 11 (col. 4, lines 17-20). As discussed above, the optical aperture in Ito is formed by FIB irradiation, not by bringing a pressing body into contact with the front end of the optical head. Thus, since the pads of Ito do not perform the identical function specified in independent claim 38 (i.e., controlling formation of the optical aperture at the front end of the tip), it cannot be an equivalent for the purposes of Section 112, 6th paragraph. Pennwalt Corp. v. Durand-Wayland, Inc., 4 USPQ2d 1737 (Fed. Cir. 1987).

Claims 39-44 depend on and contain all of the limitations of independent claim 38 and, therefore, distinguish from the prior art of record at least in the same manner as claim 38.

Moreover, there are separate grounds for patentability of several of dependent claims 39 and 44.

Claim 39 includes the additional limitation that the aperture formation controlling means comprises at least one stopper having a height substantially equal to a height of the tip of the near-field optical head. No corresponding structure is disclosed or suggested by the prior art of record.

Claim 44 includes the additional limitation that the aperture formation controlling means comprises the distance-control means for controlling a distance between the near-field optical head and the recording medium. The prior art of record clearly does not disclose or suggest means for controlling both a distance between the near-field optical head and the recording medium and formation of the optical aperture at the front end of the tip.

Claims 45-48

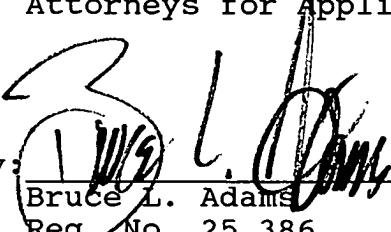
New independent claim 45 is directed to a method of producing an optical aperture and requires the steps of disposing a pressing body relative to the object so that a surface of the pressing body is disposed over the tip and the stopper portions, and displacing the pressing body to bring the surface of the pressing body into contact with the tip and the stopper portions so that a force component is directed to a front end of the tip to form an optical aperture at the front end of the tip. No corresponding steps are disclosed or suggested by the prior art of record as set forth above for independent claim 21.

Claims 46-48 depend on and contain all of the limitations of independent claim 45 and, therefore, distinguish from the prior art of record at least in the same manner as claim 45.

In view of the foregoing amendments and discussion,
the application is believed to be in allowable form.
Accordingly, favorable reconsideration and allowance of the
claims are most respectfully requested.

Respectfully submitted,

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November 16, 2004

Date